学　位　論　文　要　旨

Evaluation of the utility in camera-trap survey for wildlife population management ~ Examination for sika deer (*Cervus nippon*) ~

野生動物個体群管理におけるカメラトラップ法の実用性の評価 ～ニホンジカでの検証～

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Vital statistics are important to assessing population status, which are commonly expressed as sex ratios and fawns/100female ratios. Traditional survey on herd composition counts has been conducting by direct observation through road counts or spotlight counts, which depends on experienced observers and is influenced by deer activity and habitat use. To minimum these problems, camera-trap survey recently has been employed in various species and habitats. However, most of camera-trap survey has been conducted at baited camera sites to attract target wildlife from other areas, which sometimes lead to biased estimates.

Population density is also basic information for wildlife management and conservation. Camera-trap surveys also have been applied for density estimation in various wildlife species based on the mark–resight method. However, this method is required enormous capture efforts to obtain reliable density estimates for species without natural marking. Recently, the random encounter model (REM) using camera-trap (Rowcliffe et al. 2008) has been developed to estimate density. However, the evaluation and reliability of REM is still lucking. In addition, few studies have referred to factors affecting density estimates using camera-trap survey (Foster and Harmsen 2012).

I conducted camera-trap survey at two areas (Nakanoshima Island and the eastern area on Lake Shikotsu) in Hokkaido, Japan. I evaluate sex ratios, fawns/100female ratios, and population size in Nakanoshima Island, where population structures and population size have been monitored by herd composition

counts and drive counts, respectively in long-term. I evaluate density estimates in eastern area on Lake Shikotsu, where Takahashi (2008) has suggested that the density index indicated a low density on the basis of the threshold for preventing tree regeneration. The objectives of this study are to evaluate the use of non-baited camera-trap survey for estimation of herd composition (Chapter 3) and the utility of REM as a tool for monitoring sika deer population (Chapter 4, and 5).

Sex ratios from camera-trap survey were influenced by the number of males photographed/camera, and were positively correlated with the number of males photographed/camera, which increased in rutting season (Chapter 3). Fawns/100 female ratios also showed clear seasonal pattern with high in November and low in June during study period. These patterns have been consistent before and after culling operation during 2010–2014. Thus, reliable both ratios and overwinter mortality of fawns could be obtained from camera-trap survey in rutting season (October and November) and May.

Density estimates using REM showed a clear seasonal pattern, with high density estimates in June and October and low density estimates in December–March (Chapter 4). The speed of animal movement is required to calculate density estimates for REM, which was relatively stable during all the seasons in the study area, and there were no significant differences with that in other habitat [Shiranuka hills (Uno et al. 2010)], except during spring migration season. Using speed of animal movement at 1-h intervals of GPS location data provided most reliable estimates, which was significantly correlated to estimates from drive count (Chapter 5). However, using 3-h and 6-h intervals of GPS location data for population estimates, it resulted in overestimation compared to that of 1-h intervals ($P<0.001$). Excluding breeding, rutting, and high temperature seasons, REM provides reasonable estimates with high reliability especially in May, July, and September, and is a useful monitoring tool for sika deer population. Consequently, I suggest wildlife managers should use REM in these seasons and apply the speed of movement at 1-h intervals of GPS location data.

Camera-trap survey is superior for long-term monitoring, and useful in all weather conditions. In addition, this survey can collect seasonal patterns for sex ratios, fawn/100 female ratios, and density estimates, and automatically record large numbers of sample sizes. I recommend that wildlife managers should set cameras at non-baited deer trails to obtain sample with less bias. Additionally, I recommend that a speed of animal movement at 1-h of GPS location data for REM to obtain reliable estimates. Furthermore, I propose suitable sample size (camera trap density) and survey efforts for REM.